This listing of claims will replace all prior versions, and listings, of claims in the

application:

Listing of Claims:

(Original) In a microfiltration membrane device, for withdrawing permeate essentially

continuously from a multicomponent liquid substrate while increasing the concentration

of particulate material therein, said membrane device including:

a multiplicity of hollow fiber membranes, or fibers, unconfined in a shell of a

module, said fibers together having a surface area >1 m², said fibers being swayable in

said substrate, said fibers being subject to a transmembrane pressure differential in the

range from about 0.7 kPa (0.1 psi) to about 345 kPa (50 psi), and each fiber having a

length >0.5 meter;

a first header and a second header disposed in transversely spaced-apart

relationship with said second header within said substrate;

said first header and said second header having opposed terminal end portions

of each fiber sealingly secured therein, all open ends of said fibers extending from a

permeate-discharging face of at least one header;

permeate collection means to collect said permeate, sealingly connected in open

fluid communication with a permeate-discharging face of each of said headers; and,

means to withdraw said permeate;

the improvement comprising,

said fibers, said headers and said permeate collection means together forming a

vertical skein wherein said fibers are essentially vertically disposed and terminal end

portions of individual fibers are potted in proximately spaced-apart relationship in cured

resin;

said first header being upper and disposed in vertically spaced-apart relationship

above said second header, with opposed faces at a fixed distance;

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each of said fibers having substantially the same length, said length being from

0.1% to less than 5% greater than said fixed distance so as to permit restricted

displacement of an intermediate portion of each fiber, independently of the movement of

another fiber.

2. (Original) The membrane device of claim 1 wherein each said header is a mass of

synthetic resinous material in which said terminal end portions are potted and said

fibers are formed from an organic resinous material or a ceramic.

3. (Original) The membrane device of claim 2 wherein each said hollow fiber has an

outside diameter in the range from about 20 µm to about 3 mm, a wall thickness in the

range from about 5 µm to about 2 mm, and, said fiber is formed from a material selected

from the group consisting of natural and synthetic polymers, and pore size in the range

from 1000 Å to 10000 Å, and, said displacement is in the lateral or horizontal direction.

4. (Original) The membrane device of claim 3 wherein said transmembrane pressure

differential is in the range from 3.5 kPa (0.5 psi) to about 175 kPa (25 psi), said fibers

are in the range from 0.5 m to 5 m long, and said terminal end portions of said fibers are

potted within said mass of thermosetting synthetic resinous material to a depth in the

range from about 1 cm to about 5 cm.

5. (Original) The membrane device of claim 3 wherein said substrate is maintained at a

pressure in the range from about 1-10 atm, said fibers extend as a skein upwardly from

a fiber-supporting face of each of said headers, each header is a rectangular prism

having substantially the same dimensions, said fibers extend downwardly through the

permeate-discharging face of said headers, and said permeate is discharged upwardly

relative to said upper header.

6. (Original) The membrane device of claim 4 wherein said terminal end portions of

said fibers are potted within a mass of thermosetting synthetic resinous material to a

depth in the range from about 1 cm to about 5 cm and protrude through a permeate-

discharging face of each said header in a range from about 0.1 mm to about 1 cm.

7. (Original) The membrane device of claim 6 wherein said open ends of fibers are

bounded by a geometrically regular peripheral boundary around the outermost

peripheries of the outermost fibers in the boundary, and the length of a fiber is

essentially independent of the strength of said fiber, or its diameter.

8. (Original) The membrane device of claim 7 wherein said fibers together have a

surface area in the range from 10 to 10³ m².

9. (Original) The membrane device of claim 8 wherein said first and second headers

are each a rectangular parallelpiped and said first header is disposed parallel to said

second header.

10. (Original) In a gas-scrubbed assembly comprising, a microfiltration membrane

device in combination with a gas-distribution means to minimize build-up of particulate

deposits on the surfaces of hollow fiber membranes ("fibers") in said device, and to

recover permeate from a multicomponent liquid substrate while leaving particulate

matter therein, said membrane device comprising,

a multiplicity of fibers, unconfined in a shell of a module, said fibers together

having a surface area >1 m², said fibers being swayable in said substrate, said fibers

being subject to a transmembrane pressure differential in the range from about 0.7 kPa

(0.1 psi) to about 345 kPa (50 psi), and each having a length >0.5 meter;

a first and second header disposed in spaced-apart relationship within said

substrate;

said first header and said second header having opposed terminal end portions

of each fiber sealingly secured therein, all open ends of said fibers extending from a

permeate-discharging face of at least one header;

permeate collection means to collect said permeate, sealingly connected in open fluid communication with a permeate-discharging face of each of said headers; and,

means for withdrawing said permeate; and,

said gas-distribution means is located within a zone near the base of said skein, having through-passages therein adapted to have sufficient gas flowed therethrough to generate enough bubbles flowing in a column of rising bubbles through and around said skein fibers, to keep surfaces of said fibers awash in bubbles; the improvement comprising,

said fibers, said headers and said permeate collection means together forming a skein wherein said fibers are essentially vertically disposed and terminal end portions of individual fibers are potted in proximately spaced-apart relationship in cured resin;

said first header being upper and disposed in vertically spaced-apart relationship above said second header at a fixed distance;

each of said fibers having substantially the same length, said length being from at least 0.1% greater, to less than 5% greater than said fixed distance so as to permit restricted displacement of an intermediate portion of each fiber, independently of the movement of another fiber; and,

said gas distribution means having through-passages therein to discharge a cleansing gas in an amount in the range from 0.47-14 cm³/sec per fiber (0.001 scfm/fiber to about 0.03 scfm/fiber) in a column of bubbles which rise vertically substantially parallel to, and in contact with said fibers, movement of which is restricted within said column;

whereby said permeate is essentially continuously withdrawn while concentration of said particulate matter in said substrate is increased.

11. (Original) The gas-scrubbed assembly of claim 10 wherein said fixed distance is adjustable, said gas-distribution means includes at least two distribution means disposed, one on each side of said skein, said gas-distribution means generate bubbles having an average diameter in the range from about 0.1 mm to about 25 mm which

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bubbles contact said fibers, maintain their buoyancy, and maintain said fibers' outer

surfaces essentially free from build-up of deposits of said particulate matter.

12. (Original) The gas-scrubbed assembly of claim 11 wherein said through-passages in

said gas-distribution means generate bubbles in the size range from 1 mm to 25 mm in

relatively close proximity, in the range from 1 cm to about 50 cm, to said through-

passages.

13. (Original) The gas-scrubbed assembly of claim 10 wherein said fibers have pores in

the size range from about 1000 Å to 10000 Å, each said header is a rectangular prism

having substantially the same dimensions, said gas is an oxygen-containing gas, and

said particulate matter comprises biologically active microorganisms growing in said

substrate.

14. (Original) The gas-scrubbed assembly of claim 10 wherein said particulate matter

comprises finely divided inorganic particles.

Claims 15-22 (Cancelled)

23. (Previously Presented) In a microfiltration membrane device, for withdrawing

permeate essentially continuously from a multi-component liquid substrate while

increasing the concentration of particulate material therein, said membrane device

including:

a multiplicity of hollow fiber membranes, or fibers, unconfined in a shell of a

module, said fibers together having a surface area > 1 m², said fibers being swayable in

said substrate, said fibers being subject to a transmembrane pressure differential in the

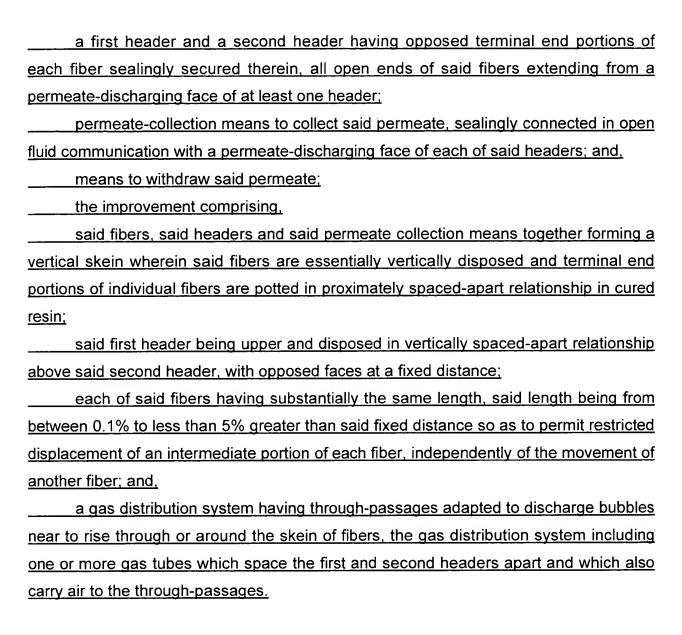
range from about 0.7 kPa (0.1 psi) to about 345 kPa (50 psi), and each fiber having

<u>length > 0.5 meter;</u>

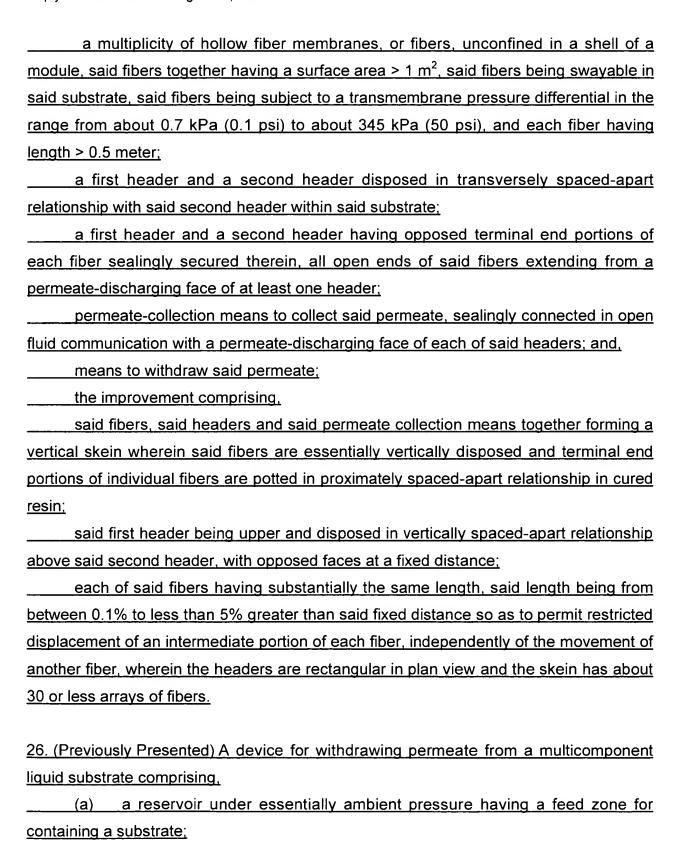
a first header and a second header disposed in transversely spaced-apart

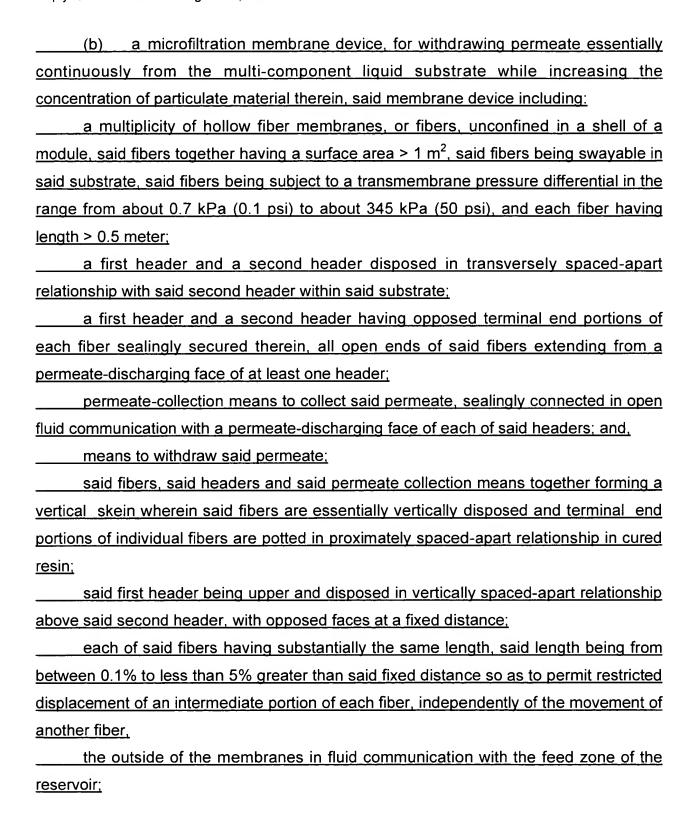
relationship with said second header within said substrate;

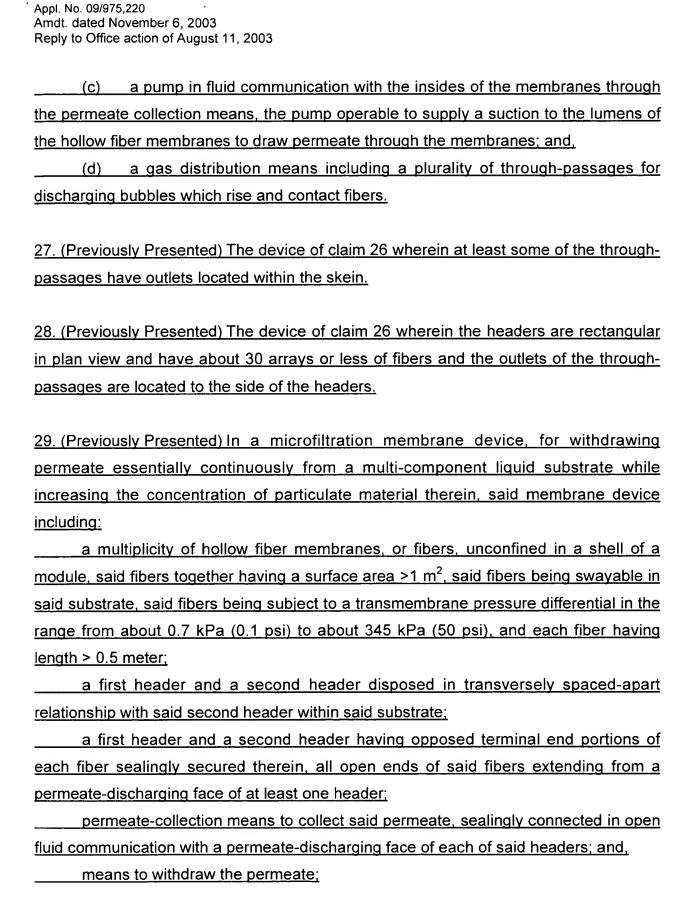
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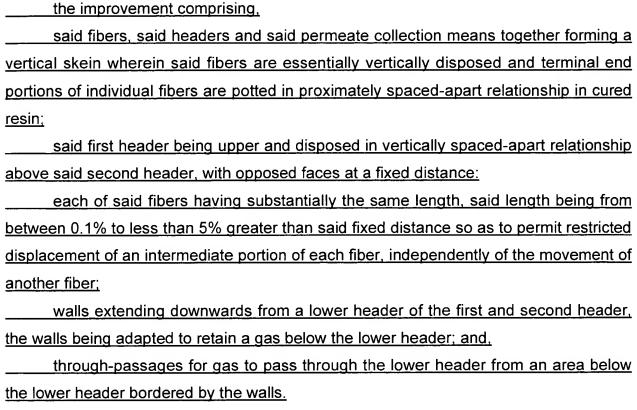
- 24. (Previously Presented) The device of claim 23 wherein the upper and lower headers are cylindrical and the one or more gas tubes are a single gas tube located in about the center of the headers.
- 25. (Previously Presented) In a microfiltration membrane device, for withdrawing permeate essentially continuously from a multi-component liquid substrate while increasing the concentration of particulate material therein, said membrane device including:







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- 30. (Previously Presented) The device of claim 29 wherein the through passages are located such that gas flowing from the area below the lower header bordered by the walls, exits between fibers.
- 31. (New) The membrane device of claim 1 wherein said fibers, said headers and said permeate collection means are all submersible below the surface of the substrate.
- 32. (New) The membrane device of clam 31 further comprising a manifold for withdrawing permeate, the manifold extending from the permeate collection means to a point above the surface of the substrate.
- 33. (New) The membrane device of claim 31 wherein the permeate collection means further comprises a pan or header enclosure covering each permeate discharging face.

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